

What is Claimed is:

1. A valve actuating apparatus for providing proportional control of a fluid flow, including:

a housing having a valve body with an inlet port and an outlet port;

a valve assembly including an armature, a movable fluid control member, and at least one spring biasing the armature into contact with the fluid control member; and

a solenoid assembly including an electromagnetic coil and a pole piece, the pole piece and the armature defining a gap that decreases proportionally to the amount of current flowing through the electromagnetic coil.

2. The valve actuating apparatus as set forth in claim 1, wherein fluid flow from the inlet port to the outlet port proportionally increases as the gap decreases.

3. The valve actuating apparatus as set forth in claim 1, further including a valve seat and wherein the fluid control member is in contact with the valve seat to inhibit fluid flow through the apparatus when the electromagnetic coil is not energized.

4. The valve actuating apparatus as set forth in claim 3, wherein the fluid control member is a ball.

5. The valve actuating apparatus as set forth in claim 1, further including a core member having a central bore and a shoulder and wherein the armature and the spring are located substantially within the core member.

6. The valve actuating apparatus as set forth in claim 5, wherein the armature includes a shoulder and the spring is positioned between the shoulder on the armature and the shoulder on the core.

7. The valve actuating apparatus as set forth in claim 6, wherein the spring is a flat spring.

8. The valve actuating apparatus as set forth in claim 7, wherein the spring has a substantially circular configuration with a central hole, a portion of the armature is inserted through the hole, and the shoulder on the armature has an outer diameter that is greater than a diameter of the hole.

9. The valve actuating apparatus as set forth in claim 6, further including a second spring having a diameter that is greater than a diameter of the first spring and that is positioned between a second shoulder on the core member and a second shoulder on the armature.

10. The valve actuating apparatus as set forth in claim 7, wherein both of the springs are flat springs with centrally located holes, and a portion of the armature is inserted through the holes, the hole of the second spring having a diameter that is greater than the outer diameter of the first shoulder of the armature and smaller than an outer diameter of the second shoulder of the armature.

11. A valve actuating apparatus for providing proportional control of a fluid flow, including:

a housing having a valve body with an inlet port and an outlet port;

a valve assembly including an armature having first and second shoulders, and first and second springs for biasing the armature; and

a solenoid assembly including an electromagnetic coil, a core member and a pole piece, the core member having a central opening and first and second shoulders, the first spring being positioned between the first shoulder on the armature and the first shoulder on the core member, and the second spring being positioned between the second shoulder on the armature and the second shoulder on the core member, the pole piece and the armature defining a gap that decreases proportionally to the amount of current flowing through the electromagnetic coil.

12. The valve actuating apparatus as set forth in claim 11, wherein both the springs are flat springs, and one of the springs has a larger diameter than the other.

13. The valve actuating apparatus as set forth in claim 12, wherein both of the springs have centrally located holes, and a portion of the armature is inserted through the holes.

14. The valve actuating apparatus as set forth in claim 13, wherein a diameter of the hole of the second spring is greater than an outer diameter of the first shoulder of the armature and smaller than a diameter of the second shoulder of the armature.

15. The valve actuating apparatus as set forth in claim 11, further including a movable fluid control member.

16. The valve actuating apparatus as set forth in claim 15, wherein the springs bias the armature into contact with the fluid control member.

17. The valve actuating apparatus as set forth in claim 16, further including a valve seat and wherein the fluid control member is in contact with the valve seat to inhibit fluid flow through the apparatus when the electromagnetic coil is not energized.

18. The valve actuating apparatus as set forth in claim 17, wherein the fluid control member is a ball.

19. The valve actuating apparatus as set forth in claim 15, wherein the fluid entering the inlet port is pressurized and pushes the fluid control member against the armature.

20. The valve actuating apparatus as set forth in claim 11, wherein at least one of the shoulders on the armature is defined by a ring attached to the armature.

21. The valve actuating apparatus as set forth in claim 20, further including a sealing member and a third spring.

22. The valve actuating apparatus as set forth in claim 21, wherein the ring is a cap, and the spring biases the seal towards the cap.

23. A valve actuating apparatus for providing proportional control of a fluid flow, including:

a housing having a valve body with an inlet port and an outlet port;

a valve assembly including an armature having first and second shoulders with different outer diameters, and first and second springs, the first spring being positioned against the first shoulder of the armature, and the second spring being positioned against the second shoulder of the armature; and

a solenoid assembly including an electromagnetic coil and a pole piece, the pole piece and the armature defining a gap that decreases proportionally to the amount of current flow through the electromagnetic coil.

24. The valve actuating apparatus as set forth in claim 23, wherein the springs are flat springs with different diameters.

25. The valve actuating apparatus as set forth in claim 24, wherein at least one of the springs has a centrally located hole, and a portion of the armature is inserted through the hole so that the spring with the hole bears against one of the shoulders of the armature.

26. The valve actuating apparatus as set forth in claim 25, wherein both of the springs have holes, and a portion of the armature is inserted through the holes, the hole of the second spring having a diameter that is greater than the outer diameter of the first shoulder of the armature and smaller than the outer diameter of the second shoulder of the armature.

27. The valve actuating apparatus as set forth in claim 23, further including a movable fluid control member.

28. The valve actuating apparatus as set forth in claim 27, wherein the spring biases the armature into contact with the fluid control member.

29. The valve actuating apparatus as set forth in claim 28, further including a valve seat, the fluid control member being in contact with the valve seat to inhibit fluid flow through the apparatus when the electromagnetic coil is not energized.

30. The valve actuating apparatus as set forth in claim 29, wherein the fluid control member is a ball.

31. The valve actuating apparatus as set forth in claim 30, wherein the fluid control member is movable relative to both the armature and the valve seat.

32. The valve actuating apparatus as set forth in claim 27, wherein the fluid is pressurized and pushes the fluid control member against the armature.

33. A valve actuating apparatus for providing proportional control of a fluid flow including:

- a housing having a valve body with an inlet port and an outlet port;

- a valve assembly including an armature, and first and second flat springs with different diameters, the springs each having a hole therethrough, and a portion of the armature is inserted through the holes in the springs; and

- a solenoid assembly including an electromagnetic coil and a pole piece, the pole piece and the armature defining a gap that decreases proportionally to the amount of current flowing through the electromagnetic coil.

34. The valve actuating apparatus as set forth in claim 33, wherein proportional control of the fluid flow is obtained.

35. The valve actuating apparatus as set forth in claim 33, further including a sealing member and a third spring, the third spring biasing the sealing member.

36. The valve actuating apparatus as set forth in claim 35, further including a cap, the spring biasing the sealing member towards the cap.